WORLD VIEW

Corneal ulceration in South East Asia. I: A model for the prevention of bacterial ulcers at the village level in rural Bhutan

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Aim: To prove that antibiotic distribution by grassroots volunteer village health workers (VVHWs) in Bhutan is an effective and efficient public health intervention for the prevention of post-traumatic corneal ulceration.
Methods: 55 villages in two districts in Bhutan were selected for the study. A defined population of 10 139 individuals was followed prospectively for 18 months by 31 VVHWs who were trained to identify post-traumatic corneal abrasions with fluorescein dye and a blue torch and to administer 1% chloramphenicol ointment three times a day for 3 days to the eyes of individuals who fulfilled the eligibility criteria.
Results: During the 18 month period 135 individuals reported to VVHWs with an ocular injury and 115 were found to have a corneal abrasion. All 115 were treated with 1% chloramphenicol ointment three times a day for 3 days and all healed without sequelae
Conclusions: Corneal ulcers that occur following traumatic corneal abrasions can be effectively prevented, even in the setting of isolated rural conditions such as those that exist in villages in Bhutan, by using relatively simple preventative measures that local VVHWs can easily be taught to employ.

The importance of corneal disease as a major cause of blindness in the world today remains second only to cataract, but the epidemiology of corneal blindness is complicated and varies from country to country and even from one population to another, depending on a number of risk factors.[1] The commonly cited causes of corneal blindness in developing countries include trachoma, onchocerciasis, xerophthalmia,[2] and leprosy,[3] but another cause, which has been frequently unrecognised, is corneal trauma.[4 5] Unlike corneal injuries in the industrialised world that are usually treated as ophthalmic emergencies, minor corneal trauma in developing countries is often considered to be trivial and is frequently ignored. In the absence of appropriate prophylactic treatment the corneal stroma can quickly become infected, an ulcer develops, and the ultimate result is severe scarring and loss of vision.[6] It is a documented fact that the majority of corneal ulcers in developing countries occur after minor ocular trauma sustained during agricultural work or in the home,[7 8] but the incidence of corneal ulceration following these superficial corneal abrasions remains unknown because control studies are ethically inappropriate. There is evidence that several hours to, sometimes, several days are required before microbial keratitis develops following a corneal abrasion. During that time there may be a ''window of opportunity'' to prevent an infection from developing.[7 8] The Bhaktapur Eye Study, a large well coordinated 2 year study conducted in Nepal, proved conclusively that post-traumatic corneal ulceration can be prevented by topical application of 1% chloramphenicol ophthalmic ointment three times a day for 3 days if given in a timely fashion to the eyes of the individuals who have suffered a corneal abrasion. Local village health workers were taught to diagnose corneal abrasions with fluorescein dye and a blue torch and then to start treatment. Maximum benefit was obtained if prophylaxis was started within 18 hours of the injury.[9] Success with the Bhaktapur Eye Study led logically to the development of further studies in three different countries in South East Asia (Bhutan, Burma, and India) that have different healthcare systems and a different spectrum of pathogens causing corneal ulceration. The first purpose of the three studies was to determine the effectiveness of the three different healthcare systems at the grassroots village level in preventing corneal ulceration following corneal injury. The second purpose was to determine the most effective medication or combination of medications needed to prevent corneal ulcers from developing depending on the prevalence of known pathogens causing ulceration in the community. This study in Bhutan is the first of the three studies to be reported.

Bhutan is an isolated Buddhist kingdom in the eastern Himalayas with a population of 650 000 ethnic Bhutanese living in the mountains, and an unspecified number of ethnic Nepalese living in the lowlands along the border with India. The population is spread out over rugged country in isolated villages of 20–25 households. In spite of their relative isolation almost all of the villages are served by an extensive rural public health network that provides basic health services, health education, immunisations, and maternal and child health services. Basic eye care is provided in the villages by the basic health units with district hospitals functioning as the first level referral centres. In some developing countries a high proportion of corneal ulcers are caused by fungal pathogens,[10] but fortunately this is not the case in Bhutan. Records at the National Microbiology Laboratory in the capital, Thimpu, indicate from hospital based data that 98% of all culture positive ulcers in Bhutan are bacterial in origin (personal communication). Because of this unique prevalence of pathogens, fungal ulcers can be effectively disregarded as a public health problem. The annual incidence of corneal ulceration in Bhutan is not known with certainty, but it is conservatively estimated by the World Health Organization that there are at least 339 ulcers per 100 000 population.[11] The goal of this study was to prove that screening of corneal abrasions by volunteer village health workers (VVHWs) and treatment with topical chloramphenicol could be successfully employed at the grassroots village level in Bhutan to prevent corneal ulceration.

Abbreviation: VVHWs, volunteer village health workers

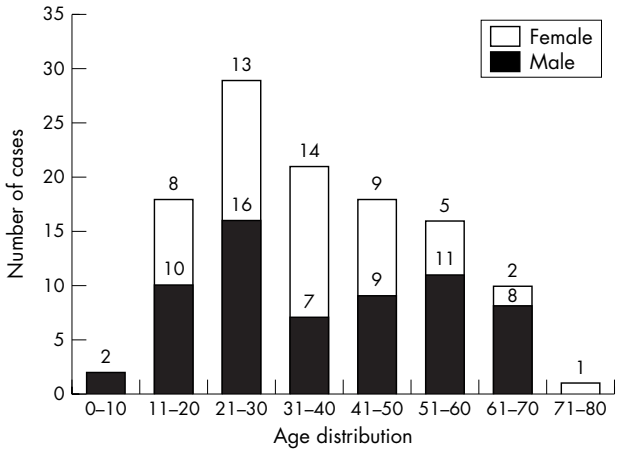

Figure 1 Age and sex distribution of 115 treated corneal abrasion cases.

METHODS

A defined population of 10 139 individuals in 55 villages in two districts was followed for 18 months. The districts of Paro and Punakha were selected for the purpose of the study. Both districts are several hours' drive over mountainous roads from the capital, Thimpu. Most of the population of Bhutan is engaged in agricultural activity, and villages are located randomly near individual rice paddies instead of being consolidated into more populous townships. To follow the defined population of 10 139 individuals for 18 months, 34 villages in Punakha District and 21 villages in Paro District were selected. VVHWs, who have the equivalent of a high school education and can write in Bhutanese and English, were utilised for the purpose of the study. These volunteers provide primary health care to the community without monetary recompense, but their positions are considered very prestigious by the villagers. The district health structure consists of a district medical officer, a district health supervisor, health assistants, basic health workers, and VVHWs. For the purpose of the study, 31 VVHWs were selected to follow the study population in the two districts. The basic health workers supervised the VVHWs. Two district health supervisors were allotted for each study district.

On average, a VVHW covered a population of around 300–350 individuals. All 31 VVHWs were given training in the anatomy of the eye and in basic eye care. They were also trained to recognise the conditions listed in the exclusion criteria of the study. Training was provided in the use of fluorescein strips and a blue torch to identify corneal abrasions. The VVHWs were also taught to record visual acuity using a one letter ''E'' chart. Training was conducted under the guidance of an ophthalmologist. The VVHWs were standardised with the ophthalmic assistants at the referral centre, the Jigme Dorji Wangchuk National Referral Hospital (JDWNR Hospital) at Thimpu. The standardisation was mainly focused on performing fluorescein staining to identify a corneal abrasion. Each worker was provided with sterile packages of single fluorescein strips, a pictorial study manual, a blue filter torch, a laminated one letter ''E'' charts, and the study medication of 1% chloramphenicol ointment in unit dose ''applicaps.'' All materials and medications were supplied by the ''coordinating centre'' at Aravind Eye Hospital in Madurai, India. In the villages, each worker allotted a room in his or her house to store the supplies and medications, to examine the patient with the eye injury, and to perform the tests. Before the commencement of the project, a publicity campaign was launched to create awareness about the study, using mass communication media such as posters, pamphlets, video screening, radio messages, and group discussions to create awareness about the study among this defined population. The effectiveness of the various publicity activities was verified randomly through awareness assessment surveys by the district supervisors every 3 months, to test for public awareness in the community.

Patients

Inclusion criteria:

- Resident of study area
- Corneal abrasion after ocular injury, confirmed by clinical examination with fluorescein stain
- Reported within 48 hours of injury
- Subject aged >5 years of age.

Exclusion criteria:

- Presence of clinically evident corneal infection
- Penetrating corneal injury including lamellar lacerations
- Bilateral ocular trauma
- Pre-existing blindness (<6/60) in the non-traumatised eye
- Initiation of topical or systemic antibiotic therapy before examination by study personnel
- Incomplete lid closure
- Diabetes
- Injuries to other vital organs/multisystem injuries requiring hospitalisation
- Trichiasis
- Dacryocystitis
- Not willing to participate.

Treatment

Those patients who fulfilled the eligibility criteria of the study were treated with 1% chloramphenicol ointment in unit dose applicaps (commercially available from Parke-Davis, Bombay, India). A verbal informed consent was obtained from the eligible subjects by the VVHWs. Subjects had one applicap of study medication applied immediately on presentation and were supplied with eight applicaps to be self administered at home. They were instructed to apply the applicaps two more times the first day and then three times a day for the second and third days for a total of nine applications of ointment over a 3 day period. The VVHWs followed the subjects daily for 3 days to confirm compliance with the medication and to note any adverse events. After the ninth application of antibiotic ointment, a repeat fluorescein stain was performed to confirm the healing of the abrasion. Compliance with medication was monitored through the collection of used empty applicaps. The end point of prophylaxis was complete re-epithelialisation of the corneal abrasion without any evidence of infection or, adversely, the development of a corneal infiltrate or ulcer at the site of the abrasion.

RESULTS

During the 18 month period (October 2002–March 2004), 135 individuals reported to VVHWs with an ocular injury. Of those individuals, 115 were found to have a corneal abrasion and 74% of the 115 came in for treatment within 6 hours of their injury (table 1). Agricultural work was the main occupation of 82%, and not surprisingly 62% of the total stated that they were injured while working in the field and 33% said that they had been injured by grass or other organic materials. Analysis of the age and sex distribution of the eligible cases revealed that 58% of the injuries occurred in the 20–50 age category, and that 52% occurred in males and 48% in females (fig 1). The 115 eligible

Table 1 Time interval between corneal abrasion and initiation of prophylactic treatment

Hours elapsed before treatment	No of patients with corneal abrasion
0–6	85
7–12	01
13–18	09
19–24	11
25–48	09
Total	115

cases of corneal abrasion that were treated with 1% chloramphenicol ointment three times a day for 3 days all healed without sequelae. There was not a single case of an adverse event, including corneal ulceration, reported during the course of the study period in spite of the fact that 20 (17%) of the 115 patients reported for treatment more than 18 hours after the injury (table 1). During the study, the most effective publicity was found to be individual door to door contact with the health workers during surveillance and spread by word of mouth among the inhabitants of the villages, followed by the display of posters and notices.

DISCUSSION

A population of 10 139 individuals living in the two districts of Paro and Punakha was kept under daily surveillance for a period of 18 months. Since the villages in Bhutan are not located close to each other and each village has only 20–25 houses, door to door contact was used as well as an extensive publicity campaign employing posters, pamphlets, video screening, radio messages, and group discussions to create awareness in the population of the necessity of full participation in the study. The most effective publicity was found to be individual door to door contact with the health workers during surveillance and spread by word of mouth among the inhabitants of the villages.

During the 18 month period of the study, 135 ocular injuries were reported in this defined population of 10 139. This total number can be expressed as an annual incidence of 888 cases of ocular injury per 100 000. There were 115 cases of corneal abrasion identified in the 135 reported injuries (85%) or an annual incidence of 756 cases of corneal abrasion per 100 000. Probably because of the active surveillance system, 74% of those who were diagnosed as having a corneal abrasion reported for treatment within the first 6 hours after the injury and the rest within 48 hours (table 1). Unlike the experience reported in Nepal,[9] ulcers did not tend to occur in patients who reported for treatment more than 18 hours after injury.

From a previous country survey in Bhutan, the annual incidence of corneal ulceration was estimated to be 339 per 100 000.[11] Assuming this incidence is valid we should have encountered 52 corneal ulcers in this population of 10 139 over the 18 month period of the study. Instead, no ulcers were seen in the study area, in spite of the fact that the annual incidence of corneal ulceration in the rest of the population of both districts (32 001) during the study period was documented by us to be 306/100 000. Even though for ethical reasons there could not be a control group (patients followed after corneal abrasion without receiving treatment), the 100% success rate of prophylaxis indicates that 1% chloramphenicol ointment given three times a day for 3 days in patients who have had a corneal abrasion is highly effective in preventing corneal ulcers in a population where the predominant pathogens are bacterial and the most frequent predisposing factor is corneal trauma. Raising the awareness in Bhutan of the peril of ulceration following corneal abrasion and the benefits of prophylaxis may explain why no ulcers were observed in this defined population over the 18 month period. In such small, closely knit communities, word of mouth and mass campaigns appeared to be very successful in raising this awareness and may have been responsible for the high rate of reporting for treatment soon after injury.

In Bhutan, health care is provided through a four tiered infrastructure of outreach clinics, basic health units, district hospitals, and regional hospitals, but it is the VVHWs at the grassroots level who have the closest contact and by implication the greatest public health impact on those individuals who live in the villages. The high rate of individual response in reporting ocular injuries, followed by the excellent levels of compliance in using the study medication, validates this hypothesis. Undoubtedly, the existing network of healthcare workers at the village level in many developing countries represents a formidable resource that can be utilised within cultural norms to prevent not only corneal ulcers following corneal abrasions but also to implement many other public health prevention strategies similar to the one described in this study.

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